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SOCIAL DETERMINANTS IN SMOKING TRAJECTORIES OVER ADOLESCENCE: A PROSPECTIVE COHORT STUDY OF PORTUGUESE ADOLESCENTS

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This research was developed in the Instituto de Saúde Pública da Universidade do Porto and Epidemiology Research Unit (UID/DTP/04750/2013) and has resulted in a manuscript entitled "Social determinants in smoking trajectories over adolescence: a prospective cohort study of Portuguese Adolescents" that will be submitted to a scientific journal.

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ABSTRACT

Background: Smoking is one of the main causes of premature death that can be prevented. As smoking usually starts during adolescence, assessing smoking trajectories is essential to design and implement effective prevention and intervention strategies.

Objective: This study aims to describe longitudinal trajectories of smoking in Portuguese adolescents and to identify its social determinants.

Methods: The present study was carried out under EPITeen cohort (Epidemiological Health Investigation of Teenagers in Porto). The total of 2942 participants were recruited and evaluated using self-administrated questionnaires at 2003/2004, 2007/2008 and 2011/2012. Smoking trajectories were defined by using data from 1194 participants who took part in the three waves with self-reported smoking status at the age of 13, 17 and 21.

Results: Four smoking trajectories were defined: non-smokers (those who never smoked n=330, 27.6%), triers (those who only have experimented, n=383, 32.1%), late-smokers (those who initiated to smoke after age of 17, n=211, 17.7%) and early-smokers (those who initiated to smoke before age of 17, n=270, 22.6%). Females are more prevalent among non-smokers and less prevalent among late smokers. To have friends who smoked was a significant social determinant of smoking trajectories for both males and females. Furthermore, parents smoke was significant for females only and household smoke was significant for males only.

Conclusions: No gender differences were found, except among those who initiated after 17. The results obtained are consistent with the third phase of tobacco epidemic, which is characterized by decrease in the prevalence of male smoking and increase in female one. Preventive measures taken in Portugal were not enough to end smoking epidemic development.

INTRODUCTION

Tobacco smoking is widespread in all countries of the world, with over 1.1 billion smokers worldwide in 2015. Smoking is one of the main causes of premature death in adults from smoking-related diseases, such as different types of cancer, cardiovascular and chronic lung diseases [1]. It is the modifiable risk factor with the highest number of deaths attributed, and, according to the Global Health Observatory, tobacco smoking accounts for the preventable death of 7 million people every year [2].

All age groups are affected by the epidemic of tobacco, nevertheless children and adolescents play an important role in this problem as smoking often begins in teen years [3-5]. Moreover, health risk behaviors with early onset as tobacco smoking have been extensively associated with long term health consequences, such as cardiovascular diseases, different types of cancer, respiratory diseases, problems with reproductive health [6]. These preventable diseases could be avoided, and, therefore, result in enormous public health benefits [7].

Additionally, tobacco smoking is one of the most important directions of World Health Organization's work regarding to its influence on public health. More than a decade after the WHO Framework Convention on Tobacco Control was introduced, a constant progress in the reaching tobacco-free environment was achieved. Given that, it is important to monitor smoking prevalence among adolescents as well as current trends for development of more tailored interventions and campaigns.

1.1 Smoking among adolescents: prevalence and current trends in Portugal

Prevalence of smoking is a subject to many methodological restrictions and usually vary from study to study [8, 9]. Analysis of national and international surveys show that there is also lack of consistency, standardization and regularity, which leads to limitation of comparability of results [8].

Another methodological problem in comparing smoking prevalence among adolescents is that the age of participants may differ within studies. It is related to the fact that the concept of adolescence roughly includes period of life between 10 and 19 years old [10]. As adolescence is a complex concept that refers not only to age, but also to physical, psychological, neurodevelopmental and social changes, inclusion criteria may be different and influence prevalence of smokers in surveys depending on the chosen methodological approach [11]. Additionally, smoking among adolescents

may have some variations in regularity from weekly to daily smoking, which makes it harder to monitor trends [12].

According to WHO, the prevalence of smoking in Europe is the highest among adults and one of the highest among adolescents [13]. In order to investigate prevalence of smoking among adolescents in Portugal, the data was extracted from the reports of two surveys of adolescents' health, namely European School Survey Project on Alcohol and Other Drugs (ESPAD) and Health Behaviour in School-Aged Children (HBSC), starting from 2001/2002 years.

The ESPAD aims to collect comparable data on substance use such as cigarette, alcohol, cannabis, inhalant and pharmaceutical use. It includes participants from 35 European countries and is conducted each 4 years. It is targeted at 15-16 years old students. The variables included in the analysis were smoking at least once in a lifetime and smoking during last 30 days. The HBSC collects data every four years on 11-, 13- and 15-year-old boys' and girls' health and well-being, social environments and health behaviours. It also has a section on substance use, such as alcohol, tobacco and cannabis. Geographically it consists of 47 countries and regions from Europe and North America. The variables included in the analysis were smoking at least once in a lifetime and daily smoking. The results obtained were compared with the average of all countries from the report and presented in the figures below.

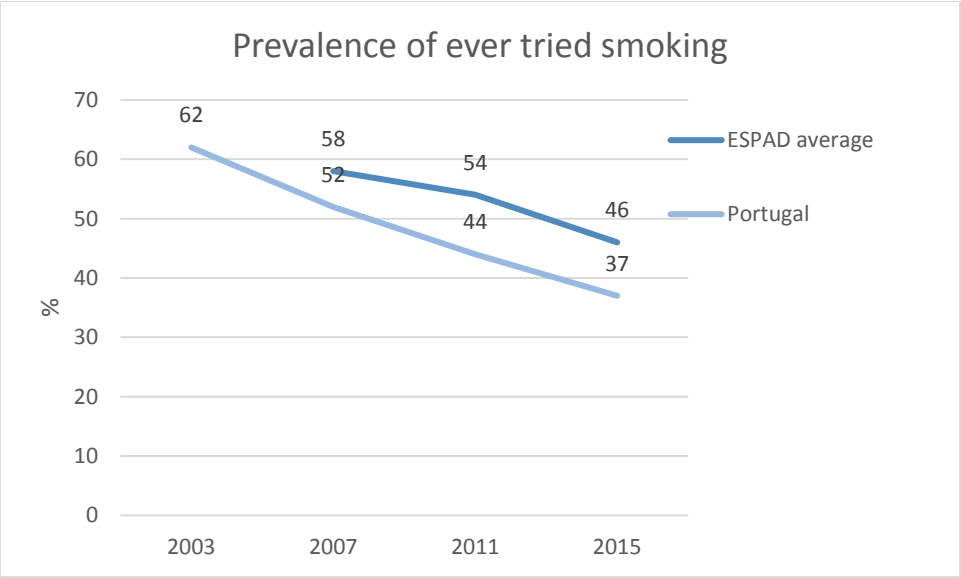

Figure 1. Prevalence of ever tried smoking in Portugal and in Europe (Adapted from: ESPAD reports for 2003, 2007, 2011, 2015 years [14-17]).

The Figure 1 shows that prevalence of smoking among adolescence in Portugal is slightly less than the average in Europe. In addition, there is a clear trend of decrease in lifetime smoking among adolescents from 2003 to 2015.

Further analysis was performed to evaluate the gender differences. The Figure 2 shows that there is no significant difference between boys and girls smoke. It also shows that smoking prevalence decreases in both genders. It means that gender gap in this age specific group narrows [14], which is consistent with other studies conducted in adolescent population [18].

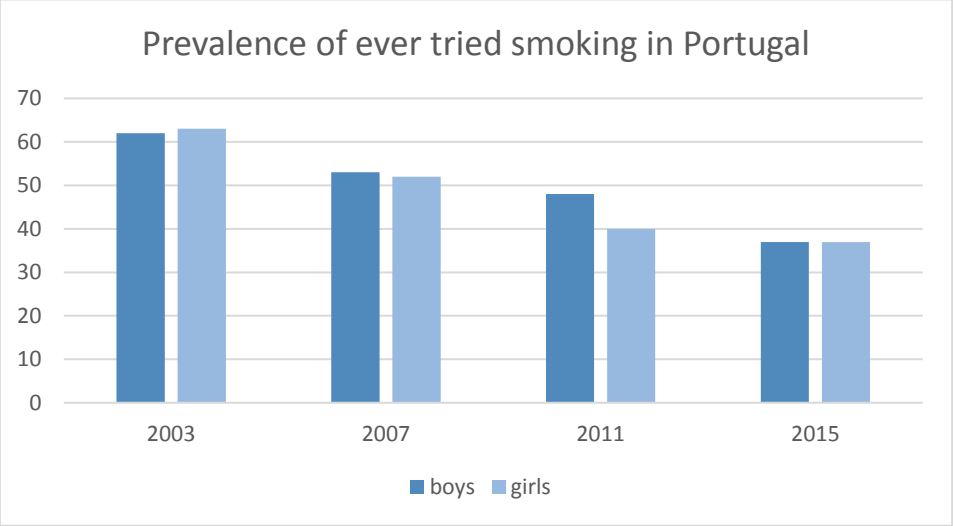

Figure 2. Gender difference in prevalence of smoking at least once in a lifetime in Portugal (Adapted from: ESPAD reports for 2003, 2007, 2011, 2015 years [14-17])

On the contrary, the prevalence of those who tried smoking in Portugal doesn't show clear linear trend. Figure 3 shows that while the average prevalence for ESPAD countries declines, Portugal has a dramatic growth in 2011. Nevertheless, prevalence of lifetime smoking in Portugal is still lower that average European prevalence with an exception of 2011, when it is 1% higher than ESPAD average.

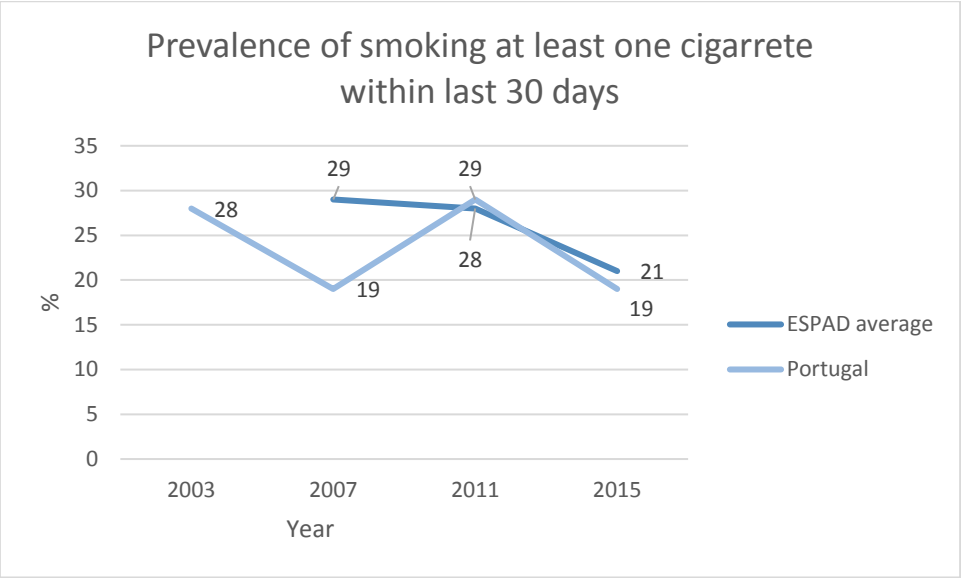

Figure 3. Prevalence of smoking at least one cigarette within last 30 days (Adapted from: ESPAD reports for 2003, 2007, 2011, 2015 years [14-17]).

Gender differences among adolescents who smoked during last 30 days in Portugal are shown in the Figure 4. This prevalence decreased among boys (with an exception of 2011), while it slightly increased among girls reaching its peak in 2015. These results may identify the need for targeted intervention to address experimentations with risky behaviour among girls as it is reported that boys and girls are affected differently by the tobacco control interventions [19].

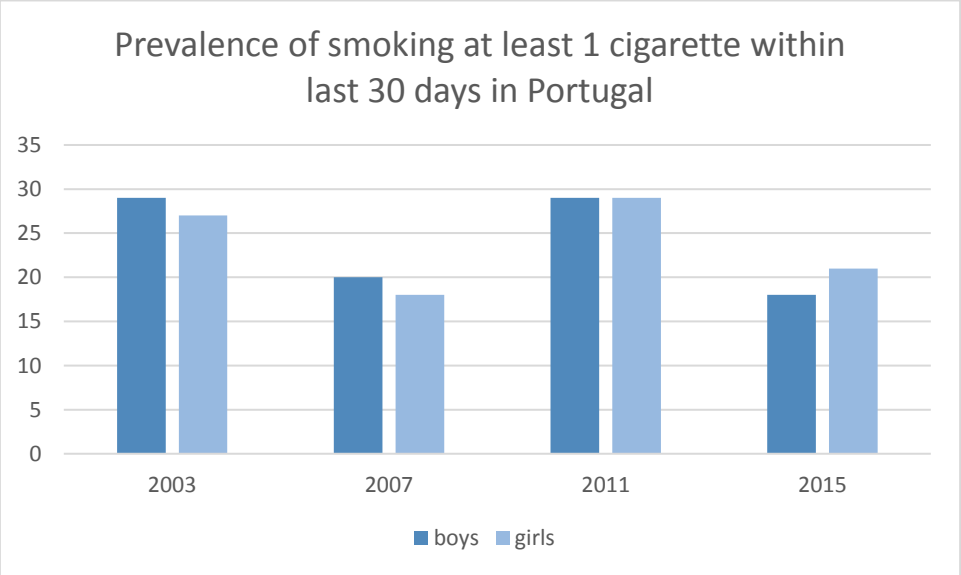

Figure 4. Gender difference in prevalance of smoking at least one cigarette within last 30 days in Portugal (Adapted from: ESPAD reports for 2003, 2007, 2011, 2015 years [14-17])

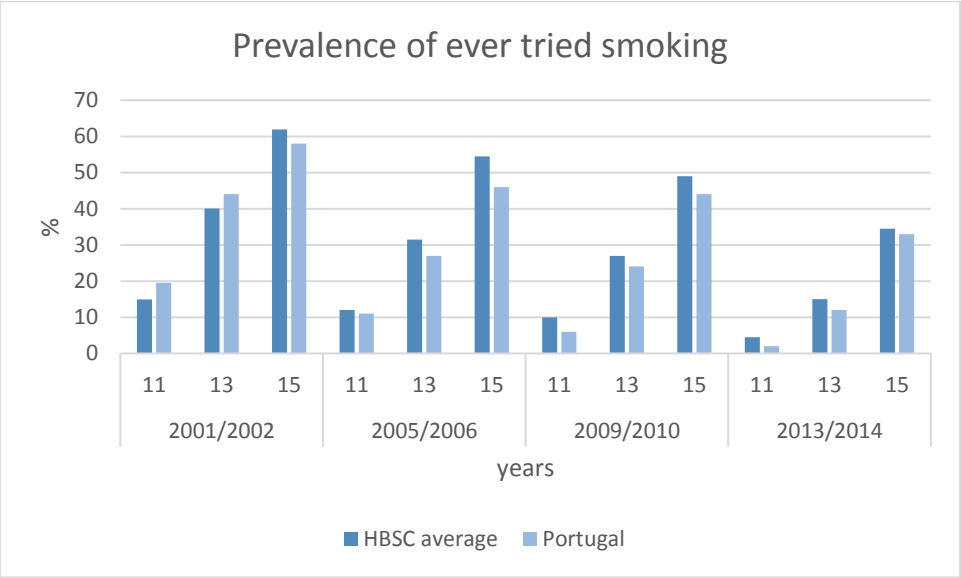

Figure 5. Prevalence of smoking at least once in a lifetime in Portugal (Adapted from: HBSC reports for 2001/2002, 2005/2006, 2009/2010, 2013/2014 years [20-23])

The evidence from the HBSC reports also supports the trend of reduction in prevalence of those who smoked at least once in a lifetime. Figure 5 shows comparison between those who tried smoking in Portugal and the average prevalence for all HBSC countries from 4 reports, namely for 2001/2002, 2005/2006, 2009/2010, 2013/2014. The data is stratified for three age groups of 11, 13 and 15 years old. According to it, the prevalence of smoking in Portugal increases with age having the lowest value at 11 and the highest at 15 years old.

This Figure also shows that prevalence among adolescence who tried smoking in Portugal is lower than the average for European and North American countries starting from 2005/2006. These results are consistent with ESPAD reports. Moreover, the percentage of those who smoked at least once among 15 years old in each wave of HBSC surveys is almost the same as in ESPAD survey, which seems to make results from both reports consistent and complementary regarding this variable.

Daily smoking in Portugal is reported to be less in comparison to the average daily smoking for HBSC countries from 2005/2006. However, while average HBSC daily smoking among 15 years old decreases from 2005/2006 to 2013/2014, prevalence of daily smoking in Portugal from the same age group remains almost the same. It seems like the interventions and measures introduced after Portugal ratified the Framework Convention on Tobacco Control in 2005 weren't effective for the respective age group.

According to the HBSC reports, no significant differences were found between genders in relation to experimentation of tobacco and smoking habits [22]. Therefore, no further analysis in regard to gender differences was performed.

The WHO Global Report on the prevalence of tobacco smoking in Portugal [2] showed that the total percentage of current tobacco smoking among adolescents (15-24 years old) was 31,1% in 2000, 28,3% in 2010 and is expected to be 25,4% in 2025.

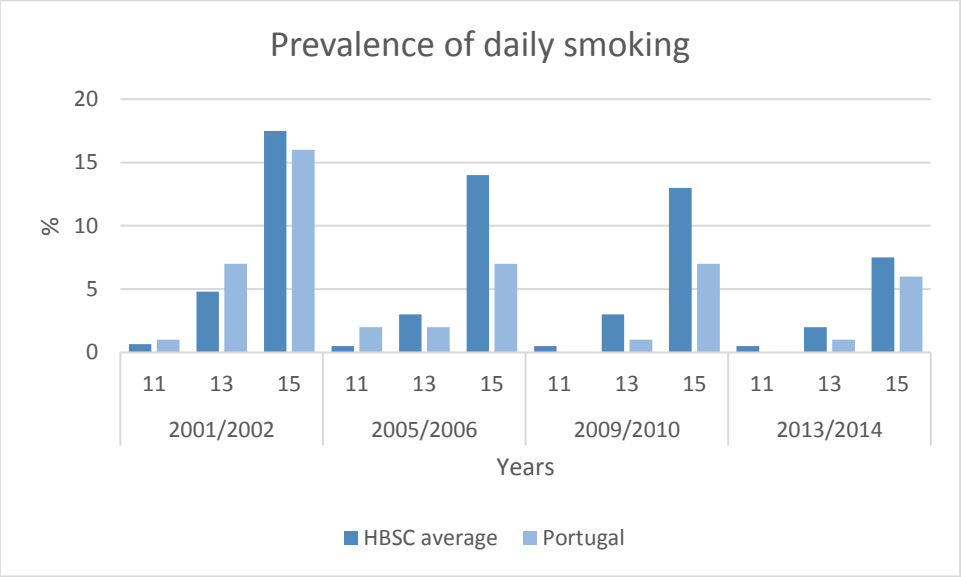

Figure 6. Prevalence of daily smoking in Portugal (Adapted from: HBSC reports for 2001/2002, 2005/2006, 2009/2010, 2013/2014 years [20-23])

This report also presented some gender differences in tobacco consumption. Boys reported to smoke twice the girls in 2000 (41,3% vs 20,6%) and in 2010 (37,6% vs 18,6%). Overall, the prevalance of smoking in Portugal among both genders decreased since 2000 and is expected to continue decreasing until 2025 (Figure 7).

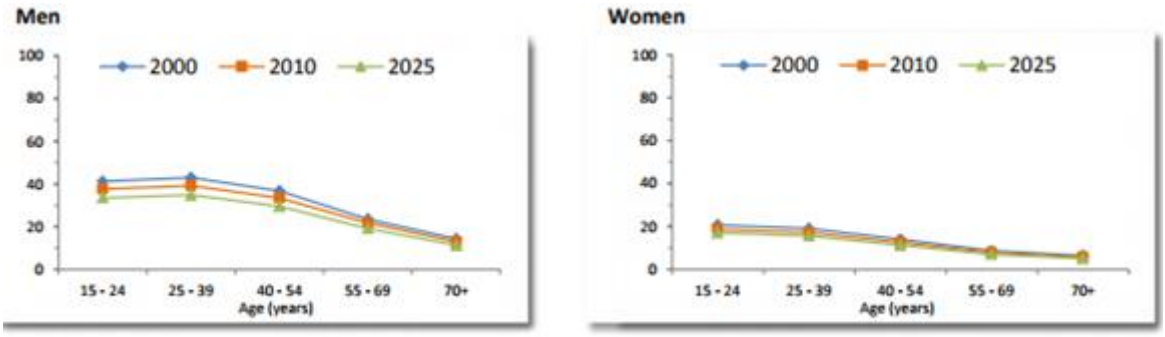

Figure 7. Fitted age-specific rates of current tobacco smoking (Adapted from: WHO Global Report on Trends in Prevalence of Tobacco Smoking [2])

Although Portugal shows lower smoking prevalence rates in the European context and it decreases overtime, particularly after Portugal ratified Framework Convention on Tobacco Control, prevalence in some age groups remains the same. These results reveal that current preventive strategies in Portugal seems not to be effective in reducing smoking prevalence among adolescents [24].

1.2 The tobacco epidemic model

The original descriptive model of tobacco epidemic was proposed in 1994 for economically developed countries. The model defined the phases of the smoking epidemic based on the comparative levels of smoking prevalence and smoking-attributed mortality in men and women [25].

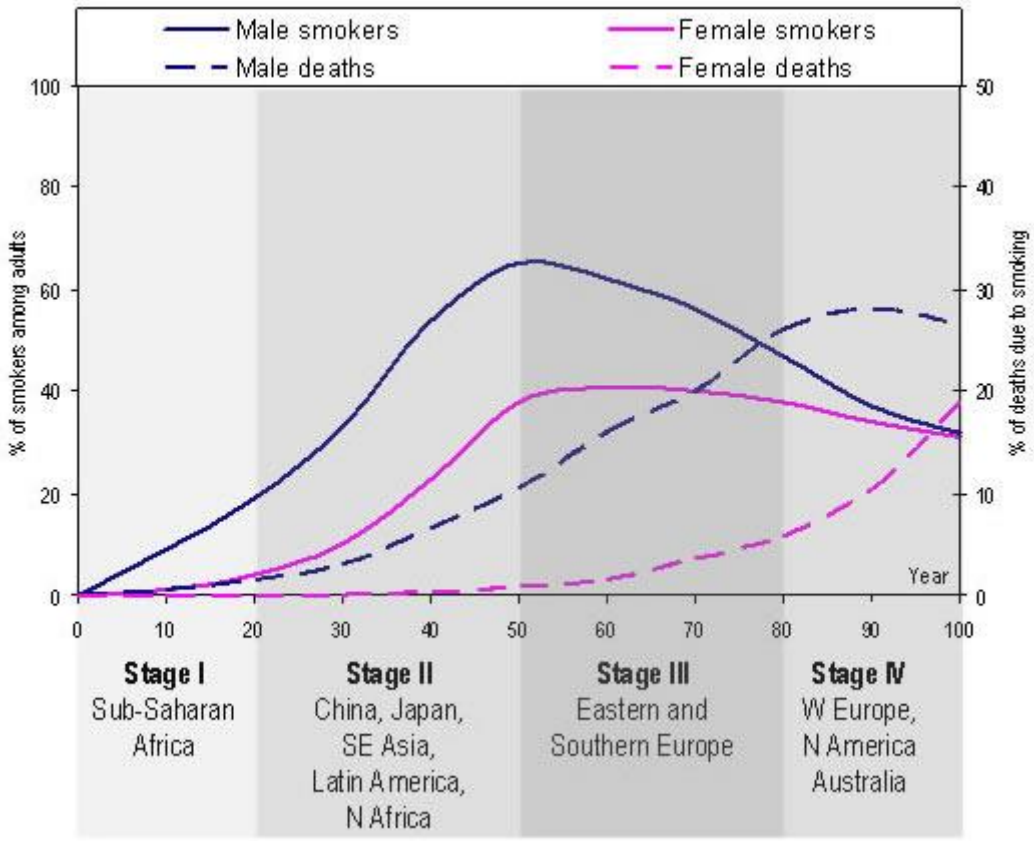

Figure 8. Lopez Descriptive Model (Adapted from: Lopez, A.D., N.E. Collishaw, and T. Piha, *A descriptive model of the cigarette epidemic in developed countries.* Tobacco Control, 1994 [25])

Figure 2 shows four stages of cigarette epidemic in developed countries. Briefly, in the first stage, smoking habit is uncommon and is a characteristic behavior among the high social classes. In the second stage smoking is more common among men of all social classes and adopted by women of high social classes. In the third stage prevalence of smoking among men drops and among women reaches the peak. In the fourth stage, smoking decreases in both sexes and is more prevalent in the lower social classes. [25]

The original and revised model underlines delay between a rapid increase in smoking and the complete increase in smoking-attributed mortality of the same generation. Thus, the III stage of the revised model explains the paradoxical period when smoking level is decreasing, but smoking-attributed mortality is still growing accordingly to the earlier increases in smoking [26].

Portugal was at an earlier stage of the epidemic compared to most developed countries [25]. A previous study carried out in Porto's adult population located Portugal in the transitional period from II stage to III stage [27]. A more recent study positioned the Portuguese women at stage II and men at the later stages of the tobacco epidemic [28]. This way the pattern of development is

characterized by a slight decrease in men and an increase in women, which leads to additional consequences to the reproductive function and outcome of pregnancy in addition to health effects such as various neurological, cardiovascular, and pulmonary diseases for both sexes [29-31].

Another recent study of socioeconomic inequalities shows that Portugal is an exception from all European countries with higher smoking rates among adolescents with high socioeconomic status (SES) [32]. This evidence locates Portugal to earlier stage of smoking epidemics than the rest of Europe and highlights the need of effective tobacco control policies in low-SES groups to prevent large health inequalities in the future [32].

Estimating the current stage of smoking epidemics is an important measure for target-oriented interventions and policies aimed to decrease the prevalence of smokers in different age-gender specific populations. It also helps to make prognoses and, therefore, to prevent the possible outcomes considering the development of smoking epidemics stages.

1.3 Health effects of smoking

Tobacco use among adolescents results in short- and long-term health consequences. Although short-term health consequences seem to be less studied, they are equally important [3].

The short-term adverse health effects caused by cigarette smoking can be observed in smokers immediately or soon after they begin smoking [33]. The short-term health consequences of smoking include respiratory and non-respiratory effects, addiction to nicotine, and the associated risk of other drug use [3, 34]. Teens who smoke are three times more likely than nonsmokers to use alcohol, eight times more likely to use marijuana, and 22 times more likely to use cocaine [3]. In addition, smoking is associated with other risky behaviors, such as unsafe driving, fighting and engaging in unprotected sex [35, 36]. Also, adolescent smokers are more likely to have seen a doctor or other health professionals for an emotional or psychological reasons [3].

Long-term health consequences of smoking include for instance atherosclerosis and cardiovascular disease [37], lung disease [38] and higher risk of several types of cancer, in particular lung cancer [39]. Furthermore, the lung growth and consequently lung function are significantly lower among smokers when compared to non-smokers, from onset of smoking and throughout life course. These differences are maintained even after quitting the habit [3]. Moreover the long-term consequences of smoking are supported by the fact that most youngsters that smoke on a regular basis and continue to smoke throughout the their life [40].

Adolescent smokers have additional health consequences regarding reproductive system due to its relation with increased risk of infertility [29, 30]. Additionally, women are at increased risk of breast cancer due to either active smoking or exposures to passive smoke, particularly if these exposures occur during adolescence or earlier in life [41-43].

Adolescents' perceptions of smoking consequences are likely to be related with the smoking initiation because adolescents tend to recognize the long-term effects of smoking but not the short-term, which makes them feel that they are safe.

1.4 Defining trajectories of smoking

The process by which adolescents progress from tobacco experimentation to regular consumption and dependence includes five stages [44]. During preparation phase acquisition of knowledge and training of beliefs and expectations about tobacco use takes place. Initiation phase relates to the consumption of the first cigarettes. Consequently, phase of experimentation is explained as the period of repeated, irregular use, which occur only in occasional situations over a period of time. Regular consumption phase happens when development of a consumption pattern is repeated and regular. The final stage - dependency phase - is a regular consumption, usually daily, mediated by the compulsive need to consume and by the appearance of abstinence syndrome [44].

The stages of nicotine dependence seem to be similar with smoking trajectories, especially regarding experimentation stage and daily smoking. It is observed differences in the classification of the trajectories, namely in the definition of smoking, methodology and data available. These differences make comparison difficult between studies that use different classifications. Table 1 shows the review of the most common definitions of smoking and smoking trajectories used in studies of adolescents' smoking.

Table 1. Studies using smoking trajectories (Adapted from: Phenotypes and endophenotypes: foundations for genetic studies of nicotine use and dependence / edited by Gary E. Swan [45])

Authors (year)	**Age** (years)/ **Grade**	**Sex** (%females)	**Definition of smoking**	**Trajectory groups**
Chassin et al. 2000	11–31	49	0 = not currently smoking 1 = up to monthly smoking 2 = up to weekly smoking 3 = weekly or more smoking, but only 10 or fewer cigarettes a day 4 = weekly or more smoking of 11–20 cigarettes per day 5 = weekly or more smoking of 20 or more cigarettes a day	Abstainers Erratics Early stables Late stables Quitters Experimenters
Colder et al. 2001	12–16	52	1 = used to smoke, but now I don't 2 = I've only tried a few puffs 3 = a few cigarettes per month or less 4 = less than a pack per week 5 = about a pack per week 6 = about one-half pack per day 7 = 1 pack per day or more	Early, rapid escalators Late, moderate escalators Late, slow escalators Stable, light escalators Stable puffers
Juon et al. 2002	6–32	52.2	Frequency and quantity of smoking	Nonsmokers Former smokers Current smokers/late adopters Current smokers/early adopters
Soldz and Cui 2002	6th–12th	55	0 = no cigarette use during the past month 1 = moderate use (≤40 cigarettes) during the past month 2 = heavy use (≥40 cigarettes) during past month	Nonsmokers Light smokers Heavy smokers
White et al. 2002	12–31	50	Frequency of smoking in the past year and typical quantity per day	Nonsmokers Occasional smokers Heavy smokers
Audrain-McGovern et al. 2004	14–18	52	0 = never smoker 1 = puffer (never having smoked a whole cigarette) 2 = experimenter (100 in lifetime) 4 = frequent (smoked ≥20 days in last 30 days and >100 in lifetime)	Early/fast adopters Late/slow adopters Experimenters Never smokers
Orlando et al. 2004	13–23	48	0 = nonsmoker in past year 1 = <3 times in past month 2 = 3–10 times in past year and <3 times in past month 3 = 11± times in past year and <3 times in past month OR 3–5 times in past month 4 = 6± days in past month and <3 cigarettes per day 5 = 6± days in past month and about one-half pack per day 6 = 6± days in past month and about one-half pack per day 7 = 6± days in past month and 1 pack or more per day	Nonsmokers Stable highs Early increasers Late increasers Decreasers Triers
Stanton et al. 2004	9–18	n.m.	Count of number of cigarettes smoked in past month	Early, rapid escalators Late, rapid escalators Late, moderate escalators Late, slow escalators Stable puffers Late, slow escalators puffers
Vitaro et al. 2004	10–15	50.7	Number of cigarettes smoked during the week and during the day before data collection	Never smokers 11–12-year-old starters 12–13-year-old starters

Authors (year)	**Age** (years)/ **Grade**	**Sex** (%females)	**Definition of smoking**	**Trajectory groups**
				13–14-year-old starters
White et al. 2004	10–25	0	At screening, if ever tried tobacco, even a puff, and if so, what age (age of onset) At subsequent assessments, lifetime use, past year use, and number of cigarettes smoked per day	Nonsmokers Occasional smokers Heavy smokers
Abroms et al. 2005	6th–9th	n.m.	0 = did not smoke in past 30 days or past 12 months and had no intention of smoking in high school 1 = did not smoke in past 30 days or 12 months but intended to smoke at least 1 or 2 times in high school 2 = smoked in the past 12 months but not in past 30 days 3 = smoked 1 to 2 times in the past 30 days 4 = smoked 3 or more times in the past 30 days	Never smokers Intenders Delayed escalators Early experimenters Early users
Karp et al. 2005	12–17	64.8	For 3-month intervals, number of days smoked each month and average number of cigarettes smoked per day each month	Low initial use, gradual increase Low initial use, rapid increase Low initial use, then increase in use, then decrease in use High-intensity initial use, then decrease in use
Brook et al. 2006	14–26	51	1 = none 2 = a few cigarettes or less per week 3 = 1–5 cigarettes per day 4 = about one-half pack per day 5 = about 1 pack per day 6 = more than 1 pack per day	Nonsmokers Maturing out Late starting Early starting
Riggs et al. 2007	12–24	44	Amount smoked per week	Abstainers Low users Late, heavy users Early, heavy users
Maggi et al. 2007 **Maggi 2008**	10–21	49.3	Separate models for probability of trying a cigarette and smoking frequency	Stable nonsmokers Late experimenters-nonsmokers Experimenters-daily smokers Late experimenters-daily smokers Early experimenters-occasional smokers Late experimenters
Bernat et al. 2008	12–19	49	Frequency of smoking (from never user to smoked most days)	Nonsmokers Triers Occasional users Early, established smokers Late, established smokers Decliners
Lessov-Schlagger et al. 2008	13–24	49	Quantity smoked in the past week	Experimenters Late increasers Early increasers Quitters Persistent

1.5 Determinants of smoking

A number of factors have been associated with tobacco smoking, namely individual (or personal), social and societal [46, 47].

Individual factors can be linked to knowledge and attitudes toward smoking, as well as self-esteem and features of character [3]. It also includes sociodemographic factors, such as gender, ethnicity, race and socioeconomic status [48].

Different smoking rates among men and women result from different smoking practices, which might be explained by discrepancies in traditional gender roles. These roles have translated historically into social norms, for instance, disapproval of female smoking, and gender-specific personal characteristics, such as greater rebelliousness among men, that might also be linked to higher smoking rates [49]. However, information on smoking trajectories by gender is not yet clearly established, as empirical studies mostly focus on variables like age of smoking onset, intensity of smoking, parental or peers smoking behavior as well as demographic characteristics namely ethnicity, area of living and parents' occupation [50, 51].

Socioeconomic status (SES) represents variables on the border between individual and economic characteristics [47]. It can be based on parents' education, family income or participants education [47]. Socioeconomic status also seem to play an important role, since adolescents from lower socioeconomic backgrounds are more likely to smoke [52]. In fact, according to Kuipers et al [32], in Portugal prevalence of smoking is exceptionally higher among adolescents with higher socioeconomic status in comparison to other European countries. Same trend is observed among adults. A study conducted in Portugal shows that smoking was initially more concentrated among both men and women with high-socioeconomic status [53]. Overall, analysis of socioeconomic status help to identify health inequalities resulting in differences in life expectancy and quality of life [54].

Social factors are usually related to peers and family influence, as well family characteristics [47]. Some studies show that having peers who smoke has stronger association with smoking than parental smoke [55]. Peers can be defined as classmates, friends, best friends, opposite- or same-sex friends, and boyfriends or girlfriends [56]. Peer tobacco use is strongly related to adolescent tobacco use initiation, maintenance and

intentions [57]. Adolescents with friends who smoke are likely to smoke themselves or to initiate smoking over some time, while best friend seems to have the strongest influence on adolescent smoking [58].

Family smoke also plays an important role in adolescent smoking [47]. Smoking of older adults, relatives' and siblings' smoking were reported to be associated with smoking among adolescents [47]. In addition, lifetime parental smoke was reported to have stronger association with adolescents smoke than current parental smoke [59]. Smoking cessation among parent may also influence adolescents' decision to ever become a smoker [60].

Societal (or environmental) factors are related with the tobacco control policies, including smoke-free legislation, taxation and regulations on sales and marketing of tobacco products [61].

1.6 Actions and intervention campaigns

The WHO Framework Convention on Tobacco Control (WHO FCTC) is the pre-eminent global tobacco control instrument, which contains legally binding obligations for its Parties and provides a comprehensive direction for tobacco control policy at all levels [62]. Portugal has ratified the WHO Framework Convention on Tobacco Control in 2005, and since then the country has invested in several prevention campaigns, including health warning labels and anti-tobacco mass media actions [63]. Following this ratification, new smoking legislation was introduced. Portuguese Law 37/2007, from August 14th, includes various aspects of the consumption, sale and control of tobacco. It also states public places where smoking is not allowed, such as schools, hospitals and theatres and introduced partial interdictions for smoking in cafes, bars and restaurants and a smoking area separated from the non-smoking one where the ventilation system is effective enough to prevent smoke from entering non-smoking area. Although most of the places adopted full or partial smoking ban, studies showed that a more comprehensive smoke-free law without any exceptions is needed to protect people from the second hand smoke [64, 65].

Portugal is reported as country with low tobacco control activities [66]. Tobacco control in Portugal is characterized as underfunded with poor implementation and enforcement, lack of public health campaigns, limited leadership of healthcare professionals and

capacity building, inconsistent smoke-free policy support and non-assertiveness from health authorities, regardless of the robust scientific and legal evidence in its support [67-69].

According to the WHO's report "Monitoring tobacco use and prevention policies" in 2007 Portugal achieved its higher level in monitoring tobacco use and in 2015 the highest level of warning about the danger of tobacco. Consequently, it is expected that the prevalence of smokers decreases in the country among all age groups by 2025 [63] .

Additionally, to support the execution of FCTC, the WHO introduced a package of six evidence-based tobacco control demand reduction measures to decrease tobacco use in 2008 [70]. These measures are known as the MPOWER package and aim to assist implementation of effective measures to reduce the demand for tobacco at country-level. MPOWER includes the following list of activities:

- **M**onitor tobacco consumption and its health effects;
- **P**rotect people from tobacco smoking;
- **O**ffer help in smoking cessation;
- **W**arn, inform and educate about the risks associated with tobacco use;
- **E**nforce bans on tobacco advertising, promotion and sponsorship;
- **R**aise taxes on tobacco.

The World Bank estimated economics of tobacco control and concluded that while measures to reduce demand (such as higher tobacco taxes, consumer information, ban on advertising and promotion and regulatory policies) are likely to be effective and don't harm economies, measures to reduce supply usually fail [71]. However, it is reported that the effectiveness of Tobacco Control policies may differ for adults and adolescents [19], therefore more tailored interventions are needed.

1.7 Prevention and strategies

In adolescents, prevention constitutes the key area of reducing tobacco consumption [3, 72]. A number of actions were implemented, such as establishment of healthy public policies at local and national levels, development of the supportive environment to reduce tobacco use, implementation of effective school health promotion programmes and development of personal skills to avoid initiation and maintenance of smoking [73].

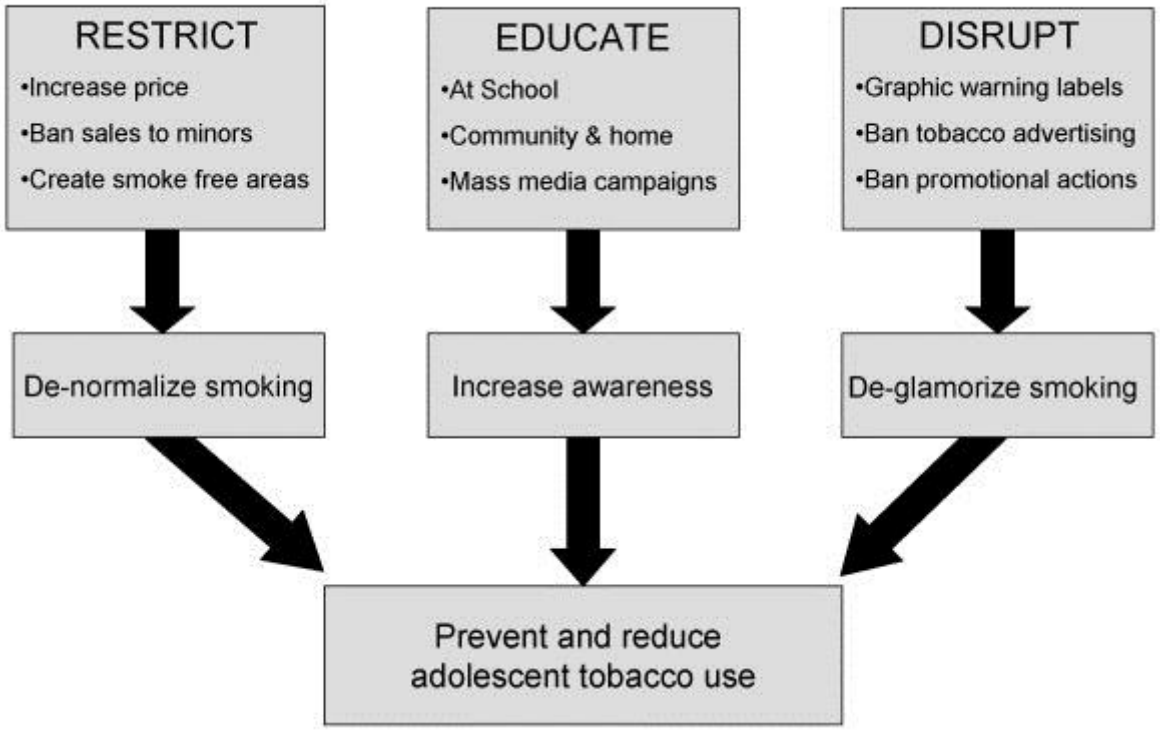

Figure 10. Tobacco control funnel (Adapted from: Vardavas, C., *Key points in preventing tobacco use among adolescents.* Tobacco Induced Diseases [74])

Figure 10 shows the three main directions of adolescents' smoking prevention and reducing, namely to restrict, to educate and to disrupt. Prevention and reduction of tobacco consumption is expected to be achieved through de-normalization of smoking, de-glamorization of smoking and increase awareness. Suggested directions are in line with the World Bank recommendations [71] and Framework Convention on Tobacco Control [62].

Tobacco users usually start smoking in their teenage years or earlier [3]. As it is expected that teenagers spend most of time at school this place is crucial for implementation of interventions and prevention campaigns [73]. Young people are at higher risk of starting tobacco use during the transition from primary to secondary school and when they socialize with older students who use tobacco [73]. So targeting adolescents is very important because this group is more likely to quit smoking successfully [75]. Preventing and delaying the age of smoking initiation should be considered during intervention planning [76], as earlier initiation was associated with lifetime smoking [3] and half of experimenters become regular smokers within a year [73].

However, school interventions alone were reported to be ineffective [77]. Among adolescents, most effects are obtained by increasing taxes and prices, restricting advertising, sponsoring media campaigns and subsidizing cessation treatment [78]. Bans or restrictions on smoking in public places is more effective for older people than youth [79]. Advertisement on sale points was found to encourage adolescents to smoke [80].

There are a few reasons why price can be an effective deterrent for adolescents. Since adolescents may not be addicted to smoking as much as long-term smokers, they may limit their cigarette consumption [81]. In addition, adolescents are more sensible to the increase in prices as their income is usually relatively small [81]. However, another study provide evidence that high price policy decrease smoking prevalence among boys only, which can be linked to the gender differences in how adolescents get cigarettes [19], since some studies found that girls tend to obtain cigarettes from social sources, such as family and friends [82, 83].

Overall, timely monitoring, interventions and prevention activities during adolescence is extremely important for avoid or delay smoking initiation and development of nicotine dependence [77]. This will prevent further health-related consequences and premature death caused by tobacco use [3].

PURPOSE OF THE STUDY

Studies show that even though prevalence of adolescents' smoking decreases overtime in Portugal, all the preventive measures undertaken seems to be not enough to stop tobacco epidemic. Understanding the patterns of smoking among adolescents and its development is essential to improve the tobacco control policy measures in Portugal. Therefore, this study aims to investigate the smoking trajectories over adolescence and to assess its social determinants, using data from the EPITeen Cohort.

RESULTS

PAPER I: SOCIAL DETERMINANTS IN SMOKING TRAJECTORIES OVER ADOLESCENCE: A PROSPECTIVE COHORT STUDY OF PORTUGUESE ADOLESCENTS

SOCIAL DETERMINANTS IN SMOKING TRAJECTORIES OVER ADOLESCENCE: A PROSPECTIVE COHORT STUDY OF PORTUGUESE ADOLESCENTS

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ABSTRACT

Objective: This study aims to describe longitudinal trajectories of smoking in Portuguese adolescents and to identify its social determinants.

Methods: The present study was carried out under EPITeen cohort (Epidemiological Health Investigation of Teenagers in Porto). The total of 2942 participants were recruited and evaluated using self-administrated questionnaires at 2003/2004, 2007/2008 and 2011/2012. Smoking trajectories were defined by using data from 1194 participants who took part in the three waves with self-reported smoking status at the age of 13, 17 and 21. Proportions were compared using Chi-square test.

Results: Four smoking trajectories were defined: non-smokers (those who never smoked n=330, 27.6%), triers (those who only have experimented, n=383, 32.1%), late-smokers (those who initiated to smoke after age of 17, n=211, 17.7%) and early-smokers (those who initiated to smoke before age of 17, n=270, 22.6%). Females are more prevalent among non-smokers and less prevalent among late smokers. To have friends who smoked was a significant social determinant of smoking trajectories for both males and females. Furthermore, parents smoke was significant for females only and household smoke was significant for males only.

Conclusions: No gender differences were found, except among those who initiated after 17. The results obtained are consistent with the third phase of tobacco epidemic, which is characterized by decrease in the prevalence of male smoking and increase in female one. Preventive measures taken in Portugal were not enough to end smoking epidemic development.

INTRODUCTION

Cigarette smoking is the most preventable cause of death although is among the leading risk factors worldwide for premature death and morbidity [1]. Smoking patterns are often established during adolescence [2], which makes this period of life of particular concern but also the main target of more effective interventions.

Smoking cigarettes is legal, addictive and does not seem to cause impairments immediately which attract youngsters for a wide range of reasons from curiosity to peer pressure [3] Adolescents usually progress through a series of stages before becoming smokers, including trying cigarettes, repeated experimentation, regular use and then dependence [4]. But in fact, smoking at younger ages leads to irreversible changes in the body organs functioning in short and long-term perspective [5, 6]

The report from the European School Survey Project on Alcohol and Other Drugs (ESPAD) for 2015 shows data valid for 35 countries in Europe targeted at students at 16 years old [7]. According to it, around half of the respondents (54% — range: 34% to 84%) had never smoked, on contrary almost quarter (21% — range: 6% to 37%) were reported as "current smokers". Although daily smoking remains more prevalent among males, overall gender gap among schoolchildren has dramatically decreased during last 20 years.

Tobacco use has been decreased in all observed European countries between 2002 and 2010, and this trend may be considered to be at least partially driven by policy measures that have been implemented in the majority of European countries in the context of the Framework Convention of Tobacco Control (FCTC) over the past two decades [8]. However, in Portugal between 1987 and 2008, the prevalence of smoking increased significantly among women of all ages except of those older than 70 years old and smoking decreased in all age-groups among men [9]. Women smokers are as likely as men smokers to suffer from many serious diseases and from early death caused by smoking but also to negative effects on reproductive health [10, 11].

Although Portugal was characterized being in the second stage of the smoking epidemics in 2003 [12], data in early adolescence seem to show that Portugal may be

now in the third stage of the epidemics as girls reported to smoke in the same proportion as boys [13].

In the last years Portugal has adopted the most important preventive guiding principles, such as information on the health hazards of tobacco, comprehensive multisectoral measures including price and tax measures, protection from exposure to environmental tobacco smoke, packaging and labelling, restriction of tobacco advertising, promotion and sponsorship, the implementation of cessation measures and limiting the access of underage persons to tobacco products [14, 15]. As a result, with all the action taken it was expected to stop the epidemic curve.

Taking advantage from a Portuguese cohort, this study aims to investigate the smoking trajectories over adolescence and to assess its social determinants. As most actions aimed to target this population group, we hypothesized that it was able to reverse the smoking epidemic.

METHODS

Study design

Adolescent participants were taken from the EPIteen Cohort, an ongoing cohort study of adolescents born in 1990, who attend private or public schools in 2003/2004 academic year [16]. The data onset was collected within three follow-up periods, respectively at 13, 17 and 21 years old. The number of the elements of was 2942.

In the first and second study waves, participants were evaluated at schools and information was collected through self-administered questionnaires. In the third study wave, participants were invited to complete the evaluation at our University department where face to face interviews and biological measurements took place, and self-administered questionnaires were completed. All procedures were standardized and performed by a team of trained health professionals.

The Ethic Committee of Hospital S. João approved this project and appropriate standard procedures were developed to guarantee data confidentiality and protection. Parents and adolescents received written and oral information explaining the purpose and design of

the study and written informed consent was obtained from both at 13 and 17 and from the participant at 21 years old.

Participants

At the recruitment, 2786 eligible participants were identified and 2159 (77.5%) agreed to participate. In the second wave, we were able to revaluate 1716 participants (79.5%) but a new group of 783 adolescents were integrated in the cohort as they moved to the area schools, and were evaluated for the first time. In the third study wave, 1764 participants were revaluated.

For the present analysis, the number of cohort elements is 1194 participants.

The gender proportion of the all samples in all three waves was 48% of men and 52% of women. The selected original sample consists of 574 male participants and 620 female participants, which itself remain the proportion of 48% and 52% respectively.

Measures and data analysis

At each follow-up participants self-reported their smoking status as “never smoked”, “only ever tried”, “occasional smoker”, “daily smoker” or “ex-smoker” (option available during third follow-up period). For the research purposes “occasional smokers” and “daily smokers” were joint into one category “smokers”. In addition, data on social-demographic characteristics of participants and their parents, smoking status of participants and their parents was collected and analyzed.

Four smoking trajectories were defined based on the self-reported smoking status of participants (non-smokers, triers, smokers after 17 years old and smokers before 17 years old). Participants reported their status as “never smoked” during all three follow-ups were considered as “non-smokers” trajectory. Participants reported their status as “only ever tried” at least once while during other follow-ups it was reported as “never smoked” relate to “triers”. Smokers after 17 years old trajectory was defined for those who reported their smoking status as “smokers” in the last follow-up (2011/2012 academic year) independently of smoking status during other follow-ups. If participant reported smoking status as “smoker” 2007/2008 and as “smoker” or “ex-smoker” in 2011/2012 follow-ups, smoking trajectory was identified as “smoker before 17 years old”. Age of 17 was chosen as the cut-point for the early- and late-established smokers

since it was the mean age of the second (middle) follow-up. Ex-smokers at the age of 21 were not computed as a separate trajectory because of the small occupancy of the category (n=43, 3,6%). They were included to the analysis based on the information about smoking initiation.

Results were stratified by gender. Chi-square tests were calculated to compare proportions. All data analysis was performed using SPSS software.

RESULTS

Four trajectories were determined based on the baseline level and the change in smoking behavior over time, namely non-smokers (n=330, 27.6%), triers (or experimenters, n=383, 32.1%), early-established (before age of 17, n=270, 22.6%) and late-established smokers (after age of 17, n=211, 17.7%). **Figure 1** illustrates those trajectories according to gender and showed that percentage of female smokers before 17 years old is in the same level as male smokers, although a high proportion of males reported to start smoke after the age of 17 compared to females. On the contrary, females presented a higher proportion that never smoked and a lower proportion that start smoking after 17 years old.

Table 1 indicates smoking status at the age of 21 according to the smoking at the age of 13 and 17. Almost half of the non-smokers at the age of 13 among females and one third among males remained non-smokers at 21, while most of the participants who have only tried smoking at the age of 13 and 17 became smokers by the age of 21. Furthermore, most participants (about 80% of females and 90% of males) reported being smokers at the early age remained smokers by the age of 21.

Table 2 shows the relationship of socioeconomic characteristics, such as type of school, parents' education, household smoking, parents smoking and friends smoking at the age of 13 and 17 with smoking trajectories separated by gender. There was no statistical significance in comparison of the difference of smoking trajectories with regard to type of school, parents' education, household smoking for females and type of school, parents' education, parents' smoking for males. Friends smoke at the age of 13 and 17 was statistically significant determinant for smoking trajectories for both males

and females. In addition, parents' smoke was significant determinant for females and household smoke was significant for males.

Table 3 shows data on smoking trajectories and parental education and stratified by parents' smoke. No significant effect of parental smoke was observed in the relationship of smoking trajectories and parental education. Although, among adolescents with non-smoking parents the prevalence of those who started smoking before 17 years old is higher among students with high educated parents.

DISCUSSION

The current study provides data on four smoking trajectories of Portuguese adolescents from 13 to 21 years old, characterizing a period of life in which smoking is initiated and established [17]. Results show a high prevalence of smoking among young people although this specific group of population was targeted by several actions and measures to prevent smoking and therefore to halt the smoking epidemic [18].

Our results show that the vast majority of adolescents is smokers. Both smokers before and after 17 accounts to 40% while non-smokers are only 27.6%. These results are consistent ESPAD survey, which reported that the majority of boys and girls aged 18 is smokers (64.6% and 64.9% respectively) [19]. In addition, our results show that the proportion of girls and boys remains the same regarding different smoking trajectories. Similar results were obtained by the Health Behaviour in School-aged Children (HBSC) study conducted in Portugal in a sample of public school students [13].

This way closing gender gap in smoking prevalence may be explained by the evolution of smoking epidemics which involves interactions between socioeconomic position and gender and is described in four stages [20]. In the first stage, smoking is an uncommon and is a characteristic behavior of the high classes. In the second stage smoking is more common among men of all social classes and adopted by women of high social classes. In the third stage prevalence of smoking among men drops and among women reaches the peak. In fourth stage, smoking decreases in both sexes and is more prevalent in the lower social classes [20].

The previous study carried out with Porto's adult population showed that they were in a transitional period from stage 2 to stage 3 in 2000 [12]. Our results seem to support that

Portugal reached the third stage, although the approached population was targeted of several campaigns and restrictive measures.

With regard to socioeconomic status, our results showed that parental education was not significantly associated with smoking trajectories over adolescence. The lack of association can be related with no significant influence of socioeconomic status in smoking behavior among this population and, therefore, this problem is affecting all the young population, independently of the socioeconomic status. Nevertheless, we would expect that parental education decreases smoking among children as it is related with parents' smoke that in turn is related with smoking in children. However, our results showed that even among non-smokers parents, those adolescents with high educated parents are more likely to start to smoke before 17, although results were not statistically significant.

Also, our results show that those who have initiated to smoke early will keep to smoke later in life, which reinforces that prevention should start earlier. Smoking or trying to smoke at early ages is sometimes dismissed as not so important because is part of adolescence to try. However, our results seem to show that when they initiate at 13 they will continue to smoke at 21, reinforcing that prevent the initiation of smoking at early ages should be the most efficient strategy. In 2005 Portugal adopted a diversified set of multi-sectoral measures to reduce the supply of tobacco, reduce demand and protect the environment [14]. In addition, various interventions were implemented during 1990-2000, such as: European Smoking Prevention Framework Approach (ESFA); The Project Cigarette-Smoking Cigarette Club (O Projecto Clube Caça-Cigarros); Program for the Prevention of Smoking Behavior in Students of the 3rd Cycle (Programa de Prevenção do Comportamento de Fumar em Alunos do 3º Ciclo). Although evidence to support school-based interventions is currently limited, but promising approaches corresponds to dealing mainly with social determinants of smoking, such as peers influence and parental smoke [21]. In addition, in 2007 a law introduced in 2007 prohibited to sell tobacco products to minors under 18 years of age [15]. However, all these several campaigns and changes in legislation that were supposed to prevent this behavior among adolescences seemed to not be effective.

To have friends who smoke was strongly related with smoking in our study. As described in previous studies, peer tobacco use is strongly related to adolescent tobacco

use initiation, maintenance and intentions [22-24]. According to the data collected by the Eurobarometer (2012), 82% of Portuguese respondents said they had started smoking due to the fact that friends smoke [25].

Overall, intervention and prevention in adolescents is extremely important regarding smoking initiation and development of nicotine dependence taking into consideration further health-related consequences caused by tobacco use. It helps to prevent long-term health problems and premature death. In addition, it decreased the number of school days missed because of respiratory illnesses.

Strengthens and Limitations

This study describes a cohort of adolescents that were recruited at the beginning of adolescence, when they tend to initiate health behaviours, and followed-up until early adulthood, when behaviours were established. This particular cohort was the main target of several campaigns and restrictive measures, and even so, prevalence data did not seem to show a reverse of smoking epidemic or large decrease in prevalence. The participants included in our analysis were recruited during the compulsory school and have followed all the participants, independently of school dropouts or alternative education programs. The sample remains stable and has 1194 participants.
This study has some limitation that are needed to be mentioned. First of all, follow-ups each 3 years don't allow to be precise in assessment of trajectories taking into account that adolescence is an important period and each year can be crucial for smoking initiation and habits change. In addition, usage of self-administrated questionnaires may affect the general quality of the data, since reported smoking status may differ from the real behavior. Differences in available smoking status categories as well as general differences in questionnaires throughout all three follow-ups may also cause some systematic errors in the analysis.

CONCLUSION

The results obtained are consistent with the third phase of tobacco epidemic, which is characterized by decrease in the prevalence of male smoking and increase in female one. It shows that all preventive measures taken in Portugal were not enough to end

smoking epidemic development. Peer tobacco use remains the key social determinant for smoking patterns of adolescents, which needs to be taken into account for planning further preventive strategies. Defining smoking trajectories and its determinants over adolescences ensures better evidence-based targeting of the interventions and therefore its effectiveness.

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TABLES

Table 1*:* Smoking status at 13 years and 17 years according to smoking at 21 years by gender.

	Female					Male				
	Smoking status at 21 n (%)					**Smoking status at 21** n (%)				
	Never smoker	Have only tried	Smoker	Quit to smoke	*p-value*	Never smoker	Have only tried	Smoker	Quit to smoke	*p-value*
Smoking status at 13										
Never smoker	195 (43.9)	129 (29.1)	100 (22.5)	19 (4.3)	<0.001	124 (27.9)	149 (33.6)	160 (36.0)	11 (2.5)	<0.001
Have only tried	6 (4.8)	43 (34.1)	65 (51.6)	11 (8.7)		1 (1.4)	17 (23.3)	54 (74.0)	1 (1.4)	
Smoker	1 (4.8)	1 (4.8)	18 (85.7)	1 (4.8)		0 (0)	1 (10)	9 (90.0)	0 (0)	
Smoking status at 17										
Never smoker	191 (54.3)	105 (29.8)	45 (12.8)	9 (2.6)	<0.001	127 (37.1)	121 (35.4)	88 (25.7)	5 (1.5)	<0.001
Have only tried	16 (8.6)	72 (38.9)	79 (42.7)	17 (9.2)		10 (6.7)	53 (35.3)	82 (54.7)	5 (3.3)	
Smoker	1 (1.3)	5 (6.5)	67 (87)	4 (5.2)		0 (0)	4 (5.7)	64 (91.4)	2 (2.9)	

Table 2: Description of social determinants by smoking trajectories among females and males.

	Smoking trajectory				
	Never smoker	Have only tried	Smoker after 17	Smoker before 17	*p-value*
FEMALES					
Type of school					
Public	143(33.1%)	131 (30.3%)	59 (13.7%)	99 (22.9%)	0.627
Private	56 (29.8%)	62 (33.0%)	31 (16.5%)	39 (20.7%)	
Parents education					
<=9 years	79 (31.0%)	91 (35.7%)	33 (12.9%)	52 (20.4%)	0.082
10-12 years	59 (33.7%)	46 (26.3%)	35 (20.0%)	35 (20.0%)	
>12 years	61 (32.1%)	56 (29.5%)	22 (11.6%)	51 (26.8%)	
Household smokers					
Yes	92 (27.8%)	106 (32.0%)	44 (13.3%)	89 (26.9%)	0.054
No	101 (38.3%)	78 (29.5%)	40 (15.2%)	45 (17.0%)	
Parents smokers*					0.017
Yes	25 (23.6%)	36 (34.0%)	11 (10.4%)	34 (32.1%)	
No	171 (34.5%)	150 (30.3%)	74 (14.9%)	101 (20.4%)	
Friends smoke (13)					
Yes	111 (28.4%)	117 (29.9%)	57 (14.6%)	106 (27.1%)	0.003
No	74 (38.9%)	65 (34.2%)	25 (13.2%)	26 (13.7%)	
Friends smoke (17)					
Yes	158 (28.6%)	178 (32.2%)	81 (14.7%)	135 (24.5%)	<0.001
No	36 (62.1%)	13 (22.4%)	9 (15.5%)	0 (0.0%)	
MALES					
Type of school					

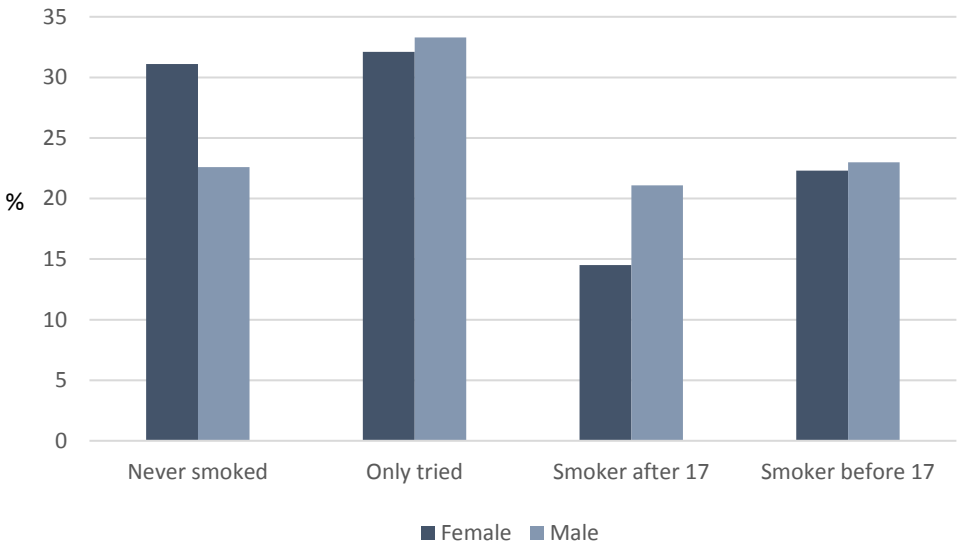
Public	94 (22.3%)	129 (30.6%)	94 (22.3%)	105 (24.9%)	0.077
Private	37 (24.3%)	61 (40.1%)	27 (17.8%)	27 (17.8%)	
Parents education					
<=9	52 (24.9%)	66 (31.6%)	48 (23.0%)	43 (20.6%)	0.633
10-12	35 (21.6%)	55 (34.0%)	37 (22.8%)	35 (21.6%)	
>12	44 (21.7%)	69 (34.0%)	36 (17.7%)	54 (26.6%)	
Household smokers					
Yes	48 (16.7%)	91 (31.7%)	66 (23.0%)	82 (28.6%)	0.001
No	71 (28.1%)	91 (36.0%)	47 (18.6%)	44 (17.4%)	
Parents smokers*					
Yes	13 (15.3%)	27 (31.8%)	20 (23.5%)	25 (29.4%)	0.242
No	109 (23.4%)	157 (33.7%)	98 (21.0%)	102 (21.9%)	
Friends smoke (13)					
Yes	43 (14.2%)	100 (33.0%)	69 (22.8%)	91 (30.0%)	<0.001
No	76 (32.8%)	79 (34.1%)	46 (19.8%)	31 (13.4%)	
Friends smokers (17)					
Yes	108 (21.2%)	166 (32.6%)	108 (21.2%)	127 (25.0%)	0.014
No	14 (30.4%)	20 (43.5%)	10 (21.7%)	2 (4.3%)	

***both parents**

Table 3. Smoking trajectories and parental education

	Parental education	**No**	**Triers**	**After**	**Before**	
Females						
Non smoking parents	Low	66 (33.2)	73 (36.7)	26 (13.1)	34 (17.1)	0.175
	Middle	46 (33.8)	36 (26.5)	27 (19.9)	27 (19.9)	
	High	54 (33.5)	46 (28.6)	21 (13.0)	40 (24.8)	
Smoking parents	Low	10 (20.0)	17 (34.0)	5 (10.0)	18 (36.0)	0.815
	Middle	9 (25.7)	13 (37.1)	5 (14.3)	8 (22.9)	
	High	5 (23.8)	7 (33.3)	1 (4.8)	8 (38.1)	
Males						
Non smoking parents	Low	42 (25.1)	53 (31.7)	38 (22.8)	34 (20.4)	0.500
	Middle	28 (21.7)	48 (37.2)	30 (23.3)	23 (17.8)	
	High	38 (22.4)	57 (33.5)	30 (17.6)	45 (26.5)	
Smoking parents	Low	6 (19.4)	9 (29.0)	8 (25.8)	8 (25.8)	0.652
	Middle	2 (8.3)	6 (25.0)	6 (25.0)	10 (41.7)	
	High	5 (16.7)	12 (40.0)	6 (20.0)	7 (23.3)	

Figure 1. Smoking trajectories during adolescence according to gender.



Supplementary Tables

Table 1. Comparison

	Entire cohort	Included participants (n=1194)
Sex		
Male	1435 (48.8%)	574 (48.1%)
Female	1507 (51.2%)	620 (51.9%)
Parents education (years)		
<9	1337 (45.4%)	464 (38.9%)
10-12	731 (24.8%)	337 (28.2%)
>12	874 (29.7%)	393 (32.9%)

Table 2. Description of sample characteristics

	n(%)
Sex	
Males	574 (48.1%)
Females	620 (51.9%)
Parents education (years)	
<=9	464 (38.9%)
10-12	337 (28.2%)
>12	393 (32.9%)
Private school at 13	
No	854 (71.5%)
Yes	340 (28.5%)
Living with parents	
Both parents	923 (77.3%)
Only mother or only father	195 (16.3%)
None of them	76 (6.3%)

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